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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Provides procedures for evaluating metal, consumable, and combustible cartridge cases. Identifies supporting tests, facilities, and equipment required. Subtests include weapon and ammunition preparation, initial inspection, ammunition characteristics, safety evaluation, environmental tests, and residue assessment. Also describes techniques used to determine ignition probability and vulnerability to fragments of consumable and combustible cartridge cases.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-103
*Test Operations Procedure 4-2-705
AD No. A091673

21 October 1980

CARTRIDGE CASES

1. SCOPE. This TOP describes the procedures for evaluating cartridge cases - metal, consumable, and combustible - to assure conformance with Required Operational Capabilities (ROCs), Development Plans (DPs), or other guidance documents. Subtests to satisfy the requirements can be selected from those listed in Paragraph 5.

*This TOP supersedes TOP-MTP 4-2-704, 24 November 1965 and TOP/MTP 4-2-705, 10 August 1966.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Firing range	Selected to suit test requirements and to provide adequate protection for personnel and equipment. Firing points must be sufficiently protected and remotely located to safely contain a premature ammunition detonation or a catastrophic weapon failure.
Temperature chamber	Capable of maintaining temperatures ranging from +63°C to -51°C and humidities from 5% to 95%.
Laboratory vibration exciter	As described in TOP 1-1-050. 1/
Drop-test facility	As described in TOP 4-2-601. 2/
Package test facility	As described in TOP 4-2-602 3/ (Appendix D).
Non-destructive test facility	As described in TOP 3-2-807. 4/
Laboratory chemical facility	To perform explosive filler exudation analysis as required.
Mechanical vibration exciter	Simulates truck bed and constantly displaces with a circular motion.

2.2 Instrumentation. Instrumentation for measuring pressure and velocity throughout the tests is covered in TOP 3-2-810 5/ and TOP 4-2-805, 6/ respectively. The photographic instrumentation available for recording the separation of parts (e.g., case mounting or locking rings) at the weapon muzzle, breech flareback, smoke, and residue are described in MTP 4-2-816. 7/

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
Crusher gages	±3% of reading**
Pressure transducers	±2% of reading**

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

**Overall precision and accuracy of current measurement systems are estimates which may be revised when an on-going study is completed.

1/, 2/, 3/, 4/, 5/, 6/, 7/ Footnote numbers match reference numbers in Appendix B.

Doppler Velocimeters	±0.15%
a. Modified HAWK CW illuminator	
b. Muzzle-velocity radar	±0.25% or 0.5 m/s (whichever is greater)
Velocity coils with sloping adapter and chronographs	
Sky screens and chronographs	±0.1%
Lumiline screens and chronographs	
Photographic equipment	
a. High-speed cameras	
b. Smear cameras	
Flash radiography (Paragraph 3.3.8)	±0.3%
Calibrated, steel, measuring tape	Distance to within ±3 mm (0.01 ft)
Meteorological equipment	
Thermograph	Temperature to ±0.4°C
Aygrothermograph	Relative humidity to ±1%
Barograph	Pressure to ±0.3 mbar
Anemograph	Wind speed to ±1.5 knots
Vane	Wind direction to ±3°
Survey equipment including telescopes and clinometers	
Fixed-focal-length lenses as required	
Light filter as required	

Supplementary lighting (flash lamps, etc.) as required.

Timing equipment as specified by Inter-range Instrumentation Group

3. PREPARATIONS FOR TESTS.

3.1 Initial Inspection. All cases are visually inspected internally and externally for dents, deep scratches, deformed rims, and other defects that might later be attributed to firing. Random samples of the test cases are examined for conformity to applicable drawings and specifications. Any defects or discrepancies found are recorded.

3.2 Preparation of Ammunition. For test purposes, the cartridge cases are assembled into complete rounds in the same manner as required for service firing. Applicable drawings and specifications for the complete rounds are observed when assembling related components to the cartridge case. When internal pressure gages (TOP 3-2-810) are used with fixed or semifixed rounds, the gages are placed in the cartridge cases before loading.

3.3 Preparation of Weapon. The weapon must be of the model which will use the cartridge case during service, or as stated in the requirements document. Stargage, borescope, and magnetic-particle inspections are performed in accordance with TOP 3-2-800. 8/

4. TEST CONTROLS. All hazardous test operations must be covered by a standing operating procedure (SOP) that provides compulsory safety measures to be followed. Safety measures for routine operations are prescribed in AMCR 385-100. 9/ The safety statement furnished by the developer is reviewed for any unusual requirements. The test plan must specify any special safety precautions and provide guidance for the writing of an SOP if no suitable SOP is available.

a. Inspect the weapon throughout testing in accordance with the schedules of TOP 3-2-800, or more frequently when there are unexpected occurrences such as projectile breakup, cartridge-case rupture, or chamber pressures 10% in excess of weapon permissible individual maximum pressure (PIMP) during a firing program.

b. If required, record surface and aloft meteorological data before, during, and after each series of firing trials as prescribed in MTP 3-1-003. 10/

c. Conduct all tests with the test items uniformly conditioned to the appropriate temperatures. Maintain temperatures to within ±1.4°C (±2.5°F). Allow sufficient temperature-conditioning time to assure complete temperature stabilization. Use thermocoupled, dummy rounds or charges to monitor temperature conditioning when appropriate.

8/, 9/, 10/ Footnote numbers match numbers in Appendix B.

d. Review radiographs and inspection results for each cartridge, prior to firing, for abnormalities which would affect performance. Some of the vibration and rough-handling tests may damage the test munitions. These items will be fired if it is judged by the tester that troops in the field would have overlooked or considered the damage negligible and fired the items; otherwise, they are disposed of without firing.

e. Continuously monitor round-by-round data to insure that critical parameters are within specified limits.

f. Conduct the 1.5-meter (5-foot), 2.1-meter (7-foot), 3-meter (10-foot - when required), and 12-meter (40-foot) drop tests prior to any other tests, if possible.

g. Conduct propellant-checkout and strength-of-design tests prior to any other firing tests.

5. PERFORMANCE TESTS.

5.1 Rough-Handling Tests.

5.1.1 Drop Tests of 1.5 Meters (5 Feet), 2.1 Meters (7 Feet), and 3 Meters (10 Feet), and Loose Cargo Test. Follow instructions in TOP 4-2-602.

5.2 Twelve-Meter (40-Foot) and Simulated Parachute Drop Tests. Follow instructions in TOP 4-2-601.

5.3 Bullet Pull Force. The force required to remove a projectile of a fixed round from its cartridge case affects the interior ballistics of a weapon. The crimping of the case to the projectile should be consistent to assure a uniform bullet pull force which is necessary for maintaining a uniform velocity from round to round. This becomes increasingly important as weapon-tube wear increases. Acceptance specifications for complete rounds require that the bullet pull force be verified as falling within specified limits.

5.3.1 Method. Insert assembled round in mechanical testing machine so that clamps grip the cartridge case while the projectile is held firmly in the crosshead, usually between the bourrelet and rotating band. Crosshead motion at specified strain rates produces hydraulic pressure in the loading cylinder of the machine. The load indication on the testing machine dial is a function of the hydraulic pressure.

5.3.2 Data Required. Peak pull force for each round.

5.4 Case Strength Test. This test is for consumable and combustible cartridge cases only and is designed to evaluate the effectiveness of the bond between case body and base.

5.4.1 Method. Clamp the projectile body in a suitable test fixture, and a prescribed longitudinal tensile load is distributed around the lip of the cartridge case base. Observe the ability of the case to withstand the load without base separation.

5.4.2 Data Required.

a. Record the longitudinal, tensile load for each round.

b. Observe results of the test.

5.5 Safety Evaluation. Safety evaluation tests are conducted to enable the test agency to recommend that a safety release for user testing be issued by TECOM (TECOM Suppl 1 to AMCR 385-12 11/). These tests provide assurance that a round containing the cartridge case under study is safe for handling by personnel. The basic guide for tests in support of a safety release for artillery and other large-caliber ammunition is TOP 4-2-504 12/ which includes subtests in Paragraphs 5.6 through 5.9 below. A test of a cartridge case in most instances requires that the case be assembled to all the components necessary to make a complete cartridge, but the projectile and fuze should be inert.

5.6 Propellant Checkout, Assessed Service Charge. This test is conducted to confirm that the service charge in a specific cartridge case will meet the weapon and/or projectile-fuze velocity and chamber-pressure requirements.

5.6.1 Method.

a. Using the assessed service charge and a "new" tube, fire a ten-round group at each propellant-conditioning temperature of +21°C, +63°C and -51°C.

b. If practical, use the type of projectile that produces the highest chamber pressure in the weapon system.

c. Make chamber-pressure versus time measurements at a minimum of two locations in the chamber, and determine the pressure differential as described in TOP 3-2-810. If differential pressure exceeds the levels described in Apprendix D of TOP 4-2-504, stop the test, and consult an interior ballistic expert.

d. The average, peak, chamber pressure at +63°C (indicated by the tourmaline gage that reads the highest) must be below the permissible individual maximum pressure (PIMP) of the weapon (or projectile) by at least three standard deviations (See Appendix C of TOP 4-2-504.). If the charge does not meet this requirement, stop testing or consider specifying a lower restrictive temperature limit for the charge.

11/, 12/ Footnote numbers match reference numbers in Appendix B.

e. The velocity at +21°C must meet system velocity requirements, and the time/pressures records at all temperatures must be examined for irregularities.

5.6.2 Data Required.

a. Date and time of firing.

b. Temperature of ammunition.

c. Muzzle velocity.

d. Weapon chamber pressure (including pressure-time and differential-pressure histories).

e. Meteorological data as required.

f. Propelling charge weight.

g. As fired projectile weight.

h. Weapon identification.

i. Elevation.

j. Observations for residue in accordance with Paragraph 5.14.

NOTE: When testing recoilless-weapon cartridge cases, an evaluation of the propellant-and-case combination to produce the proper recoilless action may be required. For this evaluation the proof test procedure of TOP 3-2-066, 13/ which uses a ballistic pendulum, can be used to measure the effectiveness of recoilless action as function of recoil momentum.

5.7 Cook-off. The tendency of propelling charges to cook-off in a given cartridge case should be examined.

5.7.1 Method.

a. Insert thermocouples to measure the temperature of the breech.

b. Place an electric heating element down the barrel into the breech of the weapon, or modify the weapon so that it can be heated from the outside with an electric coil.

c. Heat the breech until a temperature is reached that is expected to be the minimum cook-off temperature.

d. Place a projectile in the breech, close the breech, and measure the time to cook-off.

13/ Footnote numbers match reference numbers in Appendix B.

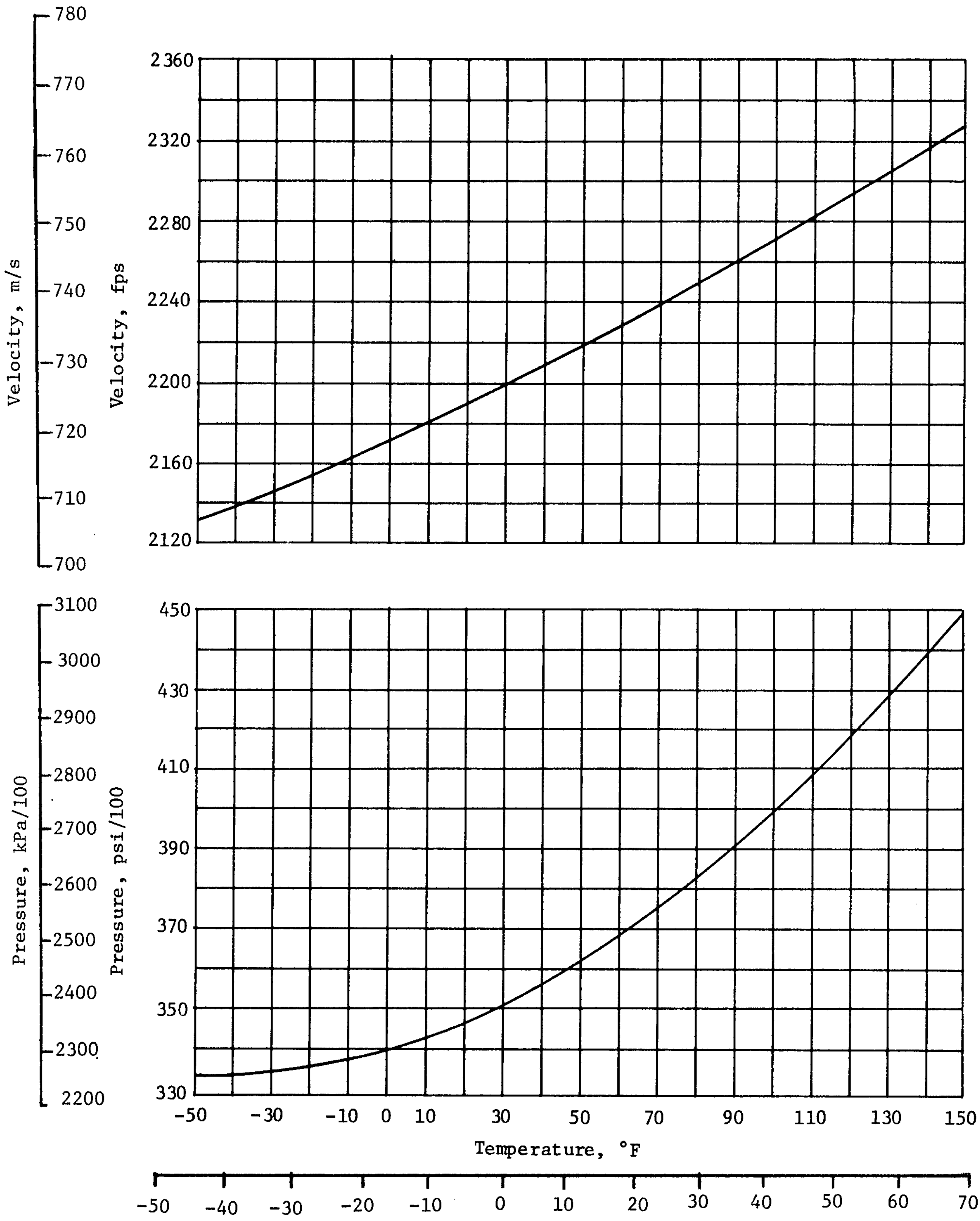


Figure 1. Velocity and pressure versus temperature.

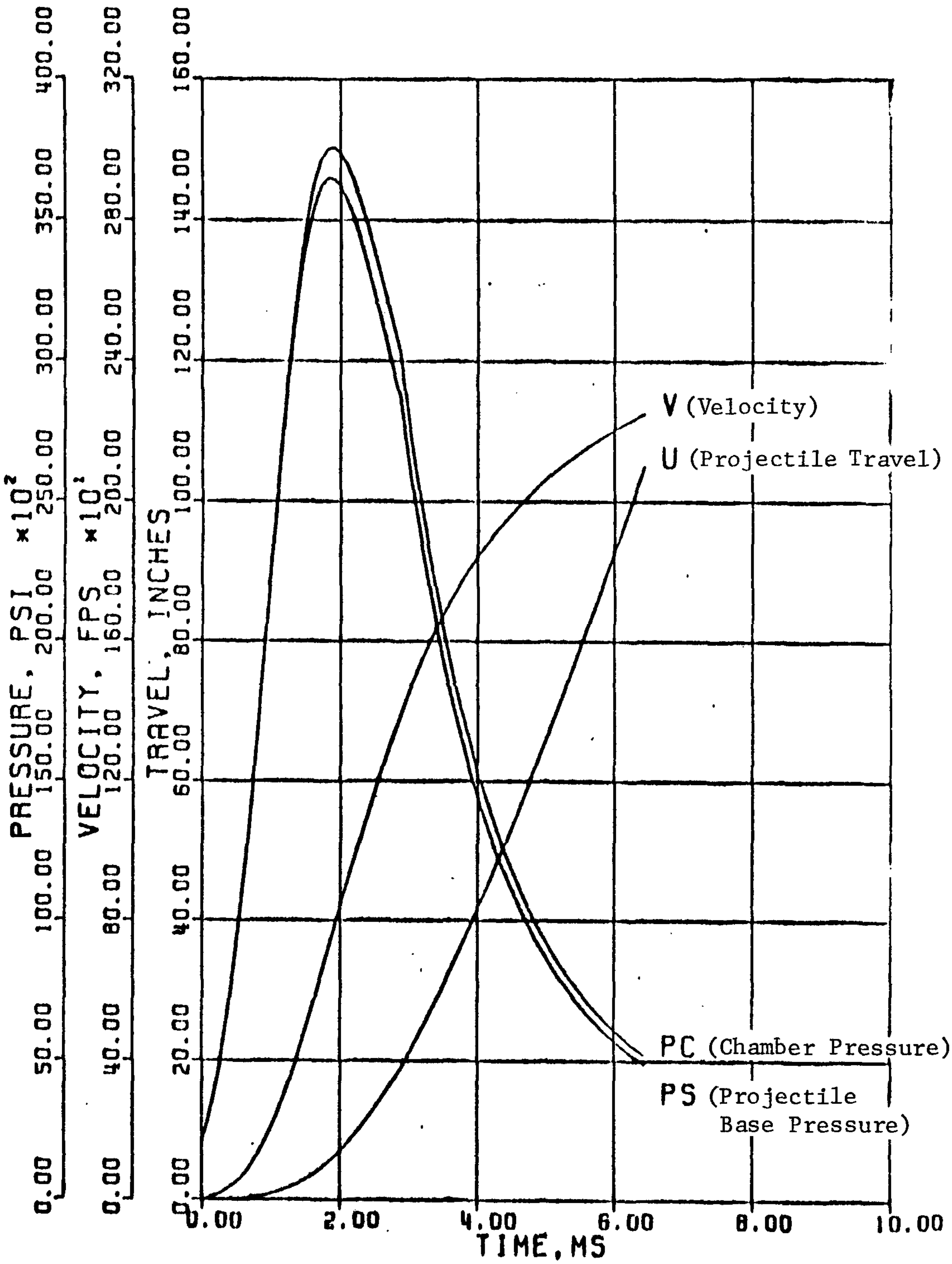


Figure 2. Pressure, Velocity, Travel versus Time.

e. Depending upon the results, make a second, and if necessary, a third attempt at cook-off by adjusting the temperature up or down. (Each time a failure to cook-off occurs, fire the projectile.)

5.7.2 Data Required.

a. Amount of time to cook-off.

b. Temperature of breech when projectile was inserted.

c. Air temperature.

5.8 Vibration Tests (Sequential). A portion of the assembled rounds to be fired are vibrated in shipping containers under conditions which simulate the transportation of the ammunition as secured cargo. For ammunition that will be carried in the ready racks of tracked vehicles, a follow-up vibration test is conducted to simulate this condition.

5.8.1 Method. Conduct tests in accordance with TOP 4-2-504.

5.8.2 Data Required.

a. Vibration schedule used.

b. Duration of vibration.

c. Test temperature.

d. Visual and x-ray observation of damage.

5.9 Storage and Operation, Hot/Dry. This test simulates storage and weapon firing in desert areas, in accordance with temperatures in AR 70-38. 14/ Conduct test in accordance with TOP 4-2-504.

5.10 Storage and Operation, Severe Cold. This test simulates sub-Arctic storage and weapon firing in accordance with temperatures in AR 70-38. Conduct test in accordance with TOP 4-2-504.

5.11 Rain.

5.11.1 Method.

a. Expose cartridge cases, assembled as complete rounds, to rain as described in TOP 2-2-815. 15/

b. Following exposure, visually examine cartridge cases.

c. Fire from the appropriate weapon, and measure muzzle velocity and chamber pressure.

14/, 15/ Footnote numbers match reference numbers in Appendix B.

d. For consumable and combustible cartridge cases, observe for residue per Paragraph 5.14.

5.11.2 Data Required.

a. Rain test employed.

b. Visual observations of leaking or wetting.

c. Muzzle velocity and chamber pressure (as compared with unexposed ammunition).

d. Observations on residue, if any, for consumable and combustible rounds.

5.12 Humidity.

5.12.1 Method.

a. Expose cartridge cases, assembled as complete rounds, to humidity test as described in TOP 4-2-820. 16/

b. Following exposure, visually examine cases for moisture damage.

c. Fire from the appropriate weapon, and measure muzzle velocity and chamber pressure.

d. For comsumable and combustible cartridge cases, observe for residue per Paragraph 5.14.

5.12.2 Data Required.

a. Humidity test employed.

b. Visual observations for moisture damage.

c. Muzzle velocity and chamber pressure (as compared with unexposed ammunition).

d. For consumable and combustible cartridge cases, observe for residue per Paragraph 5.14.

5.13 Salt Spray.

5.13.1 Method.

a. Expose cartridge cases, assembled as complete rounds, to salt-fog test as described in MIL-STD-810C. 17/

16/, 17/ Footnote numbers match reference numbers in Appendix B.

b. Following exposure, visually examine cases for salt-fog damage.

c. Fire from the appropriate weapon, and measure muzzle velocity and chamber pressure.

d. For consumable and combustible cartridge cases, observe for residue per Paragraph 5.14.

5.13.2 Data Required.

a. Salt and spray test employed.

b. Visual observations for corrosion.

c. Muzzle velocity and chamber pressure (as compared with unexposed ammunition).

d. For consumable and combustible cartridge cases, observe for residue per Paragraph 5.14.

5.14 Fungus Resistance. The fungus resistance of consumable or combustible cartridge-case material 18/ is evaluated in accordance with MIL-STD-810C. A soil burial test may also be conducted, where, in addition to fungi, the specimens are exposed to other organisms present in soil, such as bacteria and actinomycetes.

5.14.1 Method.

a. Expose consumable or combustible cartridge cases in accordance with MIL-STD-810C.

b. Following exposure, visually examine the cases and fire from the appropriate weapon.

-- and if required --

c. Conduct soil burial test by first cutting from cartridge cases a group of identical samples 1 by 6 inches in length.

d. Break several unexposed samples in tensile machine.

e. Bury others vertically in soil beds composed of equal parts of humus, topsoil, and sand.

f. Maintain beds in a tropical chamber at 95% humidity and +29°C for 20 hours per day followed by 4 hours per day at 100% relative humidity and +26°C. Incubate for 6 weeks.

18/ Footnote numbers match reference numbers in Appendix B.

5.14.2 Data Required.

a. For MIL-STD-810C record the following:

(1) Observe susceptibility to fungus attack.

(2) Muzzle velocity and chamber pressure (as compared with unexposed ammunition).

(3) Observe for residue per Paragraph 5.14.

b. For soil burial test record the following:

(1) Observe susceptibility to fungus attack.

(2) Change in breaking strength.

5.15 Residue. In testing consumable or combustible cartridge cases, observations are continually made during test firings to determine the extent and characteristics of residue left in the chamber of the weapon.

5.15.1 Method.

a. Set up motion picture camera for coverage of the breech opening to supplement visual observation of residue after firing of cartridge cases.

b. Set up real-time IR scanning camera (Methodology Investigation [19/]) behind the breech of the weapon and focused so that, when the breech opens after firing, the whole inner tube of the weapon can be examined.

c. Fire rounds under the designated climatic conditions.

NOTE: With the use of a portable IR reference source, it is possible to calibrate the IR scanning camera to determine the temperature of the smoldering-residue particles.

5.15.2 Data Required.

a. Fire from the appropriate weapon, and measure muzzle velocity and chamber pressure.

b. Type of instrumentation.

c. Location and size of residue particles by visual observation of the weapon.

d. Extent of residue in the weapon chamber by motion picture coverage.

19/ Footnote numbers match reference numbers in Appendix B.

e. Incidents of smoldering residue.

f. Temperature of smoldering-residue particles by calibration of the IR scanning camera.

g. Photographs of collected, remaining residue, if possible.

h. Data for all extreme climatic conditions (i.e., extreme temperatures (Paragraphs 5.9 and 5.10, rain (5.11), humidity, (5.12), salt spray (5.13), and fungus (5.14), as well as a sample of firings under normal conditions.

NOTE: Firings that produce smoldering residue in a hazardous location (i.e., breech chamber or forcing cone of the gun tube) are counted as contributing to the total-system probability (P_t) discussed in Paragraph 5.16 below.

5.16 Ignition Probability. Consumable and combustible cartridge cases are evaluated for the probability of being ignited from smoldering residue prior to breech closing. It should be noted that this evaluation covers only one aspect of the hazard situation described by the following equation:

$$P_t = P_r \times P_b$$

where

P_t = Total probability that a cartridge case will be ignited by smoldering residue.

P_r = Probability that smoldering residue is left in a hazardous location when ammunition is fired.

P_b = Probability that a cartridge case, placed against smoldering residue will ignite before the block is locked (ignition propensity).

The term P_t is the total-system hazard specified by the requirements document. In determining P_t, P_b tests are emphasized based on the assumption that if P_b is small, the P_t requirement may be met even though P_r is equal to 1.

5.16.1 Fizz-Burning Test. The first task in determining P_b is to demonstrate that single-layer case burn-through will not occur before breech closure.

a. Method.

(1) In a laboratory, condition test pieces of cartridge cases 2.5 by 5 cm for a specified moisture content (e.g., 1.5% by weight) by drying at +52°C for 24 hours at a controlled, relative humidity.

(2) To achieve fizz ignition, ignite a separate piece of case material (approximately 1 cm square) with a soldering iron and place on the test piece.

b. Data Required. Record time from ignition of the top surface of the test piece until burn-through. The number of trials to determine minimum burn-through is decided after initial testing.

5.16.2 IR Camera Test. Another technique for determining cartridge case burn-through time is the IR scanning camera.

a. Method.

(1) Cut sample cartridge case specimens 2.5 cm square and mount each vertically with the inside face of the case sample in view of the IR camera.

(2) Ignite the case sample on the side opposite the camera (outside) with a soldering iron preset to a temperature of approximately +454°C, or other temperature as specified.

b. Data Required. Measure the time from ignition (smoking) until the other side of the specimen reaches a preset black-body reference temperature. The time of burn-through is defined as the time from ignition (burning) on the outside surface until black charring is observed on the inner surface.

5.16.3 Complete-Round Test. For this test use pieces of cartridge case material (approximately 2.5 cm by 0.6 cm by 0.3 cm thick) to simulate residue in the breech chamber.

a. Method.

(1) Place residue piece in the breech chamber at the 6 o'clock position one-third, one-half or two-thirds of the way forward from the breech face.

(2) Ignite with a controlled-heat source such as a soldering iron.

(3) After the flame subsides, the cartridge case, loaded with 0.225 kg of black powder and attached to a projectile, is loaded into the breech and breech closure is initiated.

(4) Observe ignition and breech closure with two 24-frame-per-second motion picture cameras.

(5) Make 100 attempts.

b. Data Required.

(1) Non-ignition of the cartridge case before breech closure is a satisfactory result.

(2) Monitor and record the breech-motor current with a time-based strip chart to determine the start and finish of breech closure.

(3) Record the functioning of the 0.225-kg, black-powder charge used to propel the projectile at minimum velocity from the tube with a pressure transducer. The pressure is recorded on the same strip chart as the breech-motor current.

(4) Drill two 0.3-cm holes through the face of the chamber, one for transducer to record pressure, and one for a motion picture camera to observe ignition.

(5) Place a clock, accurate to ±0.05 second, in the field of view of the camera observing the functioning of the charge. Place a small box with red and green lights in view of this camera to measure breech-closing time. When breech closing starts, the red light goes on, and when closed, the red light goes off, and the green light goes on.

(6) Using the P_b test results, divide the number of unsatisfactory attempts by the number of attempts to obtain a point estimate of P_b. Calculate the upper 95% confidence limit. It is assumed that the point estimate of P_b is a binomially distributed random variable.

5.17 Vulnerability to Fragments. This test is conducted to evaluate cartridge cases with their protective media (ballistic bag, container, etc.) for resistance to ignition due to fragment impacts. The basis of evaluation is comparing the 50-percent-probability ignition point of the test case to other cases tested under the same conditons. [20]

5.17.1 Method.

a. Place test case with propellant and proof slug, but without a primer, in a plane a realistic distance behind and parallel to a plate of armor whose type, obliquity, and thickness is representative of the vehicle in which the ammunition will be carried (Figure 3).

b. Attack with either API or AP projectiles that can defeat the armor.

20/ Footnote numbers match reference numbers in Appendix B.

c. For heavy armor also use statically detonated HEAT projectiles.

d. Vary the position of the test case from the line of fire (d, Figure 3) along the parallel plane.

e. Move the next case away from the line of fire by a distance equal to the diameter of the case, each time cartridge case ignition occurs.

f. Move the case toward the line of fire by a distance equal to the diameter of the case, each time there is no ignition.

g. This up-and-down method is similar to that described in TOP 2-2-710.[21]

5.17.2 Data Required.

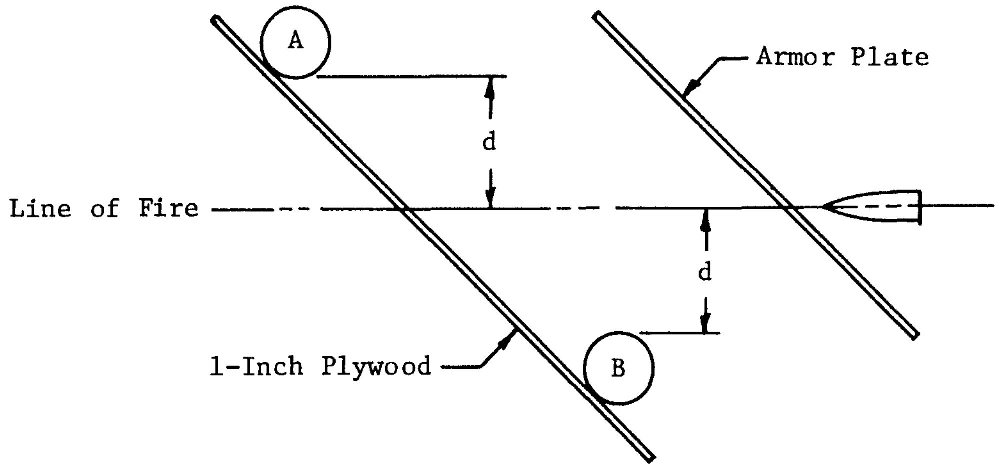
a. Estimate the off-line distances (d) at which 0- and 100-percent probabilities of ignition occur.

b. Obtain the off-line distance at which the 50-percent probability of ignition occurs by the method of maximum likelihood for which a computer program[22] exists at Aberdeen Proving Ground.

c. An alternate method is to average the distances of the three closest cases resulting in non-ignition and the three farthest cases resulting in ignition.

d. Record events behind the armor plate with high-speed camera coverage.

21/, 22/ Footnote numbers match reference numbers in Appendix B.



A - Test case position for gun-fired projectile attack
B - Test case position for detonated projectile attack
d - Distance varied to determine 50% point

Figure 3. Fragmentation Attack Configuration.

6. DATA REDUCTION AND PRESENTATION.

a. Reduce and summarize data from performance tests in accordance with the TOP appropriate to the class of item under test.

b. Describe inspection results for conformity to applicable drawings and specifications.

c. Assemble and tabulate all results and safety information generated during the preliminary safety tests, including any hazards that could occur or increase as a result of storage.

d. Combine propellant checkout data and other data generated at different temperatures to produce a pressure-temperature relationship, plotted on a curve.

e. Evaluation of pressure-time and differential-pressure records will be analyzed in accordance with Figure 2, to determine propelling charge safety.

f. Time-based strip chart records pressure after functioning of 0.225-kg, black-powder charge used to propel projectile at minimum velocity.

g. As required, provide still photographs of significant results of fragment impacts and record behind-the-plate functioning with a high-speed camera (black and white) and a normal-speed camera (color).

h. After firing a round, observe for residue and record type, location, approximate size, and if smoldering. Recycle breech and scavenge residue, if any, from gun.

i. The following are required for residue in the chamber:

(1) Record breech motor current with a time-based strip chart, and photograph the time from initiation of breech closing to breech locking for the duration of the tests.

(2) Record time from initiation of breech closing to case ignition with a motion picture camera for the duration of the tests.

(3) Determine the number of ignitions prior to block closing with a motion picture camera, and make a statistical analysis.

j. For consumable and combustible cartridge cases, provide photographs of typical residue comparisons.

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APPENDIX A
BACKGROUND

A cartridge case is the part of a round of ammunition that contains the propelling charge and its associated ignition system. Its profile and size conform to the chamber of the weapon in which the round is fired. Metal cartridge cases, when inserted in the chamber of an artillery weapon other than a recoilless rifle, also act as obturators for the propelling charge by preventing the rearward passage of propellant gases into the threads and other parts of the breech mechanism.

Three types of rounds require cartridge cases: fixed rounds, semifixed rounds, and separated rounds.

a. In fixed rounds, the cases are assembled with the primer and propelling charge. The projectile is seated in the mouth of the case and crimped so that a uniform force is required to separate the projectile from the case. The type of crimp and the bullet pull required are shown in the complete-round drawing. Recoilless rifle ammunition is also included in the fixed-round category of ammunition.

b. Cartridge cases for semifixed rounds are assembled in the same manner as the fixed rounds, except that the propelling charge is divided into separate sections (assembled in bags) and in the projectile is fitted into the mouth of the case, but is not crimped. This propelling charge may be adjusted as desired by removing the necessary number of propellant increments.

c. In the separated round the complete round is divided into two units: (1) the propelling charge, which is contained in the cartridge case together with the ignition system and the closing plug, and (2) the projectile.

Metal cartridge cases are fabricated from either brass or steel, though there have been experimental ones made from aluminum. Steel cases are classified by method of manufacture; i.e., drawn-steel cases for use in high-pressure weapons and under high temperatures, spiral-wrapped cases, and the multipiece cases for use in recoilless rifles.

Consumable and combustible cases, as their names imply, are designed to be expended during the propelling charge combustion process. Consumable cases are fabricated of organic materials of high enough porosity to permit flame penetration. In the process of burning, this case material contributes nothing to the energy of the propellant system. Combustible cases contain varying amounts of a low explosive such as nitrocellulose and thus contribute a small amount of energy to the system. Combustible cases are usually restricted to use in low-pressure systems in which it might be difficult to achieve complete burning of a consumable case.

Consumable and combustible cartridge cases are not necessarily completely consumable or combustible. If the weapon for which the case has been designed does not have a self-obturating breech mechanism, the case must be designed to facilitate obturation. This entails a metal base for the case which must be ejected or extracted after firing. These cases are designed as partially consumable or partially combustible cartridge cases and are usually designed as an interim solution for firing in existing weapons. It is anticipated that most future weapons will be designed to provide self-obturation and thus permit the use of completely consumable or combustible cases.

Some experimental cases have been made of plastic and a combination of plastic and metal.

APPENDIX B
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